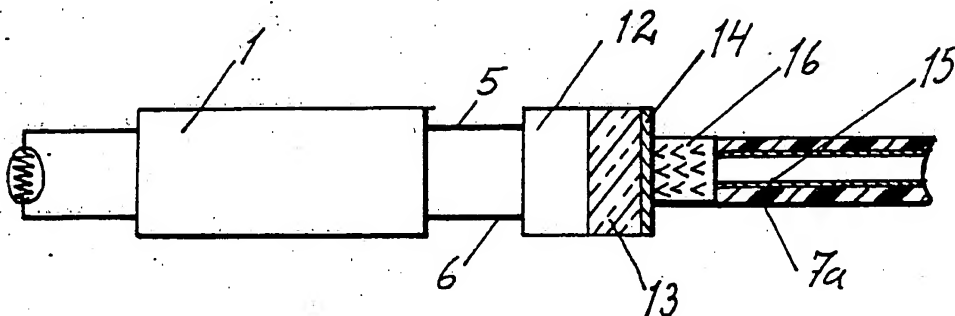




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(54) Title: AN IGNITION SYSTEM AND A METHOD FOR THE INITIATION THEREOF



(57) Abstract

The disclosure relates to a method for initiating, i.e. starting, an electronically delayed-action ignition system for explosive charges, the system being entirely protected against disturbance by electromagnetic waves. According to the invention, at least a part of the pressure, heat or light energy generated from, for example, a detonating fuze (7) upon a primary detonation, is utilized for starting the time igniter (1) which in turn after a preset time-lag initiates the explosive main charge. The present invention also includes devices adapted thereto including, for instance, photocells (12), electrolytes (11) or piezoelectric transducers (8).

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TITLE OF INVENTION:

AN IGNITION SYSTEM AND A METHOD FOR
THE INITIATION THEREOF

TECHNICAL FIELD

The present invention relates to a method of initiating, i.e. starting, an electronically delayed ignition system for explosive charges, the ignition system being entirely protected from disturbance by electromagnetic waves. The present invention also relates to an ignition system functioning in accordance therewith and being of a specific design.

BACKGROUND ART

In the employment of electric ignition systems for initiating explosive charges, nearby radio and radar stations - as well as other sources of radiation - constitute potential risks, since they could give rise to sufficiently powerful induced currents in the ignition wiring to cause accidental initiation of the charges. This is a serious drawback which is inherent in all electric ignition systems and which has entailed that, in electrical ignition systems intended for military applications, it has been necessary to incorporate complex anti-disturbance systems, since, in field-service use it cannot be anticipated - as in civilian blasting operations using electrical ignition systems - that all use of radio, radar or other radiation transmitters in the vicinity of the explosion site can be prevented.

It has previously been common for electrically initiated blasting cartridges (blasting caps) also to be provided when necessary with pyrotechnical delay charges of conventional type. However, electronic delayed action igniters with very good performance as regards precise and well-known ignition intervals and small outside dimensions have recently become available at highly attractive prices.

These electronic delayed action igniters constitute a further argument in favour of choosing an electric instead of a non-electric ignition system in the initiation of explosive charges. However, as soon as an electric ignition system is employed in which the electric wires are of sufficient length to run the risk of induced currents in the wires, there will be the additional requirement of accurate and therefore also complex and expensive disturbance shielding of the entire ignition system.

Consequently, it would in many cases be desirable to have access to a non-electric ignition system which could offer the same exact time lag as the electronic time igniters and which could never be achieved using even the best pyrotechnical delay charge.

SUMMARY OF THE INVENTION

The present invention relates to a disturbance-shielded, electronically delayed ignition system for explosive charges in which the ignition system is initiated by detonation, or high-energy combustion, for instance of a pyrotechnical charge or the like, triggered in the immediate vicinity of the ignition system. According to a primary variant of the present invention, the initiating effect on the ignition system is achieved by means of a detonating fuze fired in its vicinity. The effect initiating the ignition system may then, in accordance with the secondary variant of the present invention, be amplified by or replaced by, for instance, a more slowly burning pyrotechnical charge. According to the present invention, at least a portion of the energy generated on detonation or combustion is converted into electric current of sufficient power to energize an electronic

time igniter which, in turn, initiates the desired detonation after a preset interval.

By employing a detonating fuze such as a pentyl fuze or a low-energy fuze of the type which consists of a tube interiorly coated with a primary explosive for initiating electrically delayed the igniter, access will thus be created according to the present invention to an ignition system which is entirely free of disturbance in respect of induced currents in the ignition system, at the same time as the electronic delayed action - with its extraordinarily high precision - gives an ignition precision in time which today is impossible to achieve using exclusively pyrotechnical igniters.

Detonating fuzes of the pentyl fuze type, or the low-energy fuze briefly described in the foregoing will, on firing, always give rise - to a greater or lesser extent - both to a shock wave and to heat and light generation. According to the present invention, all of these forms of energy may be utilized for initiating different variants of the igniter designed according to the present invention. The difference between these igniter variants lies in which of the energy forms generated by the detonating fuze is utilized for initiating the electronic time igniter, and how this initiation is implemented. As already intimated, other types of detonations or combustion giving rise to sufficient shock waves, light or heat generation may also be employed for initiation of the ignition system according to the present invention.

According to a first variant embodiment of the invention, use is made of that shock wave which, for instance, a detonating fuze generates to influence a proximally disposed piezoelectric transducer to generate an electric pulse which may charge a capacitor connected to the transducer to a sufficient voltage in order that this, in turn, discharge across an electronic delayed-action igniter interconnected therewith, the igniter, after a preset delay interval initiating, via very short electric wires, a conventional electric igniter. All of the components included in

this igniter variant are of per se known type. Moreover, state-of-the-art technology makes it possible to miniaturize all the components, with the possible exception of the electric igniter. Since the miniaturized components require no other
5 external supply of energy than the shock wave which is to activate the piezoelectric transducer, the entire igniter may advantageously be moulded in some suitable plastic and be given a practicable outer configuration with, for example, a tunnel or groove for guiding a detonating fuze to sufficient proximity to
10 the piezoelectric transducer. The electric igniter and its detonator (if any) may either be incorporated together with the other components in the thus obtained igniter body or be connected, in a conventional manner, with conductors which are sufficiently short that they could not be influenced induced
15 currents.

The above generally described igniter contains only very short electric conductors which may advantageously be grouped on a circuit board. This means that the risk of induced currents in the electric conductors may be disregarded. Consequently, the igniter
20 according to the present invention will be completely free of disturbance in respect of electromagnetic waves etc. from nearby radio or radar transmitters.

According to a second variant of the present invention, use is made of the heat generated by the detonating fuze to melt down,
25 and thereby start, current emission from an electrolyte of the type which only emits current when the electrolyte is in the molten state but not when it is in the solid state. The current emitted by the molten electrolyte is now utilized to initiate the same type of electronic time igniter as that employed in
30 conjunction with the first variant of the present invention. Also according to this second variant of the present invention, the entire igniter may be of extremely compact form, with the whole of the ignition system well encapsulated and entirely protected from disturbance in respect of electromagnetic waves. When a detonating
35 fuze is utilized to emit heat, the effect thereof may be amplified by an extra pyrotechnical charge.

The detonating fuze is suitably led through a channel or a groove through the igniter separated from the electrolyte by, for instance, a metal wall of good thermal conductivity and suitably also good thermal storage capacity so that the heat generated on detonation of the fuze may be utilized to maximum benefit in the electrolyte.

According to a third variant of the present invention, use is made of the light generated on detonation of the detonating fuze to act on a photocell which, in turn, starts an electronic time igniter of the same type as was employed in the previously-mentioned variants of the present invention. In this variant of the present invention, the needle flame formed on detonation of the fuze - possibly amplified by an extra pyrotechnical charge - may also be used to burn off a safety layer which wholly screens the photocell from all surrounding light up to the detonation of the fuze. The safety layer may, for instance, consist of an aluminium coating on a glass panel or glass lens which screens off the photocell and the electronic time igniter from the detonating fuze. In this variant of the present invention, use may advantageously be made of a detonating low-energy fuze for the initiation.

Such a low-energy fuze can thus consist of a plastic tube interiorly coated with minor amounts of primary explosive, for example of the octogen type. In such low-energy fuzes as are started by means of a normal detonating high-energy fuze, for example a pentyl fuze, the detonation wave follows the explosive coating along the interior of the tube. In this third variant of the present invention, such a tubular low-energy fuze could thus be terminated by a conventional pyrotechnical charge which is defined by an aluminium-foil coated glass lens behind which the photocell and the electronic time igniter connected therewith are placed. Finally, the time igniter is connected by suitable means to a blasting cap or detonator of conventional type.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The present invention has been defined in the appended Claims and will now be described further with particular reference to the accompanying Drawings. In the accompanying Drawings:

5 Fig. 1 shows a schematic section taken through a shock-wave initiated igniter variant;

Fig. 2 is a schematic section of a thermally initiated igniter variant; and

10 Fig. 3 is a schematic section of a light-initiated igniter variant.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the Drawings, the igniters illustrated in Figs. 1, 2 and 3, which are elaborated in accordance with the three different main variants of the present invention, all include a
15 number of identical components and these have all been given corresponding reference numerals.

All igniters thus include an electronic time igniter 1. This, in turn, is disposed, after a preset time interval on being itself initiated, to initiate the final ignition function. In the
20 Figures, this final ignition function is marked by an electric ignition bead 2 supplied via leads 3 and 4. The final ignition function may, however, be elaborated in any other per se known manner, or even in accordance with hitherto unknown ignition technology, since this does not form an embodied part of the
25 present invention.

The ignition bead 2 shown in the Figures may, for example, be combined with a detonator of per se known type. The time igniter, in turn, is started by a current which is supplied to the time igniter via leads 5 and 6 from a transducer which is capable of
30 transforming at least parts of the energy generated on detonation in the vicinity of the transducer into an electric current.

According to the variant shown in Fig. 1, the transducer which is to convert energy from the detonation into electric current is a piezoelectric transducer 8 disposed close to a
35 detonatable fuze 7. A protective foil 9 is disposed between the

transducer 8 and the fuze 7. When the fuze 7 is detonated, the transducer 8 receives a shock wave that generates an electric pulse which, in turn, charges a capacitor 10 which discharges across the time igniter 1, thereby starting the igniter. When the delay interval preprogrammed into the time igniter has expired, the time igniter initiates the ignition function 2. When the transducer is initiated by a detonatable fuze, this may either be drawn transversally past the transducer as shown in Fig. 1, or endwise to the transducer as in Fig. 2. Other detonating charges may also be employed to initiate the transducer.

In the variant illustrated in Fig. 2, use is made of the heat which is generated upon detonation of the fuze 7 to melt down an electrolyte disposed near the fuze 7, the electrolyte being of the type which emits battery current only in the molten state but not in its solid state at normal temperature. The electrolyte is designated 11. It is separated from the fuze by a protective wall 9 so as not to be burst and spread upon detonation of the fuze. From the electrolyte, two electric leads 5 and 6 run to the electronic clock 1. From the time igniter 1 and start thereof, all components and function are identical with the system according to Fig. 1.

In the variant of the present invention illustrated in Fig. 3, the time igniter 1 is started by a photocell 12 which is connected to the electronic time igniter 1 by means of leads 5 and 6. A protective lens of glass 13 is disposed between the photocell and the detonating fuze. This protective lens is, in turn, coated with a safety layer facing towards the fuze and consisting of a material which may be burnt off, in this particular case, an aluminium foil 14. This thus constitutes a safety function which effectively prevents all light from reaching the photocell 12. In the embodiment shown in Fig. 3, use is made of a detonating low-energy fuze of the type which consists of a plastic tube 7a interiorly coated with a primary explosive charge 15. Since this does not possess sufficient combustion energy to burn off the protective layer 14, a special pyrotechnical charge 16 has been

disposed in conjunction with the protective layer. The pyrotechnical charge 16 also serves to provide a longer light impulse so that the photocell will have time to react. The low-energy fuze 7a may be replaced by a pentyl fuze of normal quality.

5 When the fuze 7a detonates and the pyrotechnical charge 16 is combusted, the protective layer 14 will be combusted at the same time, the light generated by the flame influencing the photocell 12 which, via leads 5 and 6, starts the electronic time igniter which, after the preprogrammed time lag, thus initiates the
10 ignition function 2 via ignition leads 3 and 4.

WHAT WE CLAIM AND DESIRE TO SECURE BY LETTERS PATENT IS:

1. A method of realizing and initiating an electronically delayed ignition system for explosive charges, said system being fully protected against disturbance by electromagnetic waves, characterized in that an electronic delayed-action igniter with very short leads is connected on the one hand to a transducer capable of converting at least a portion of the energy that is developed upon a detonation or other pyrotechnical combustion in its vicinity into an electric current, and, on the other hand, to a conventional electric igniter; and that said transducer is in turn caused by a detonation or other pyrotechnical combustion in its immediate vicinity to deliver a current shock of sufficient magnitude to start the delayed action igniter so that this, after a preset time-lag interval, in turn initiates the electric igniter.

2. A disturbance-protected igniter for explosive charges designed in accordance with the method as claimed in Claim 1, characterized in that it includes an electronic delayed-action igniter (1) connected to an electric igniter (2-4) of per se known type, said delayed-action igniter being in turn coupled to a transducer (8, 11, 12) capable of converting the energy that is generated upon a detonation or alternatively other pyrotechnical combustion in the vicinity of the transducer (8, 11, 12) into an electric current of sufficient magnitude to start the electronic delayed-action igniter (1).

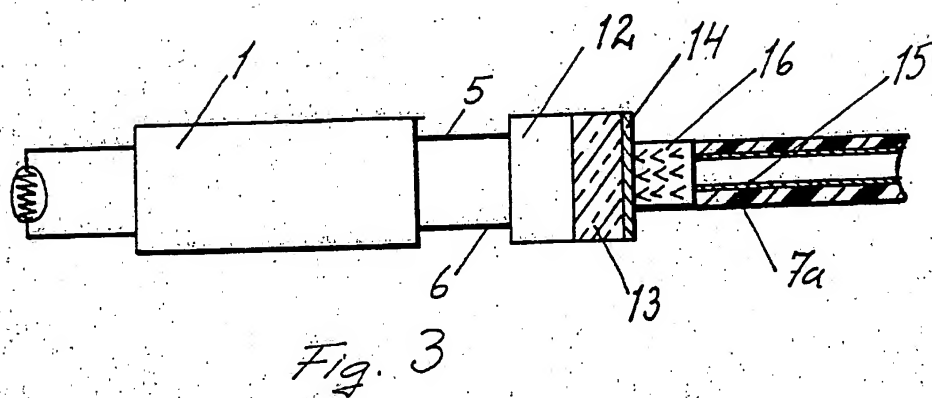
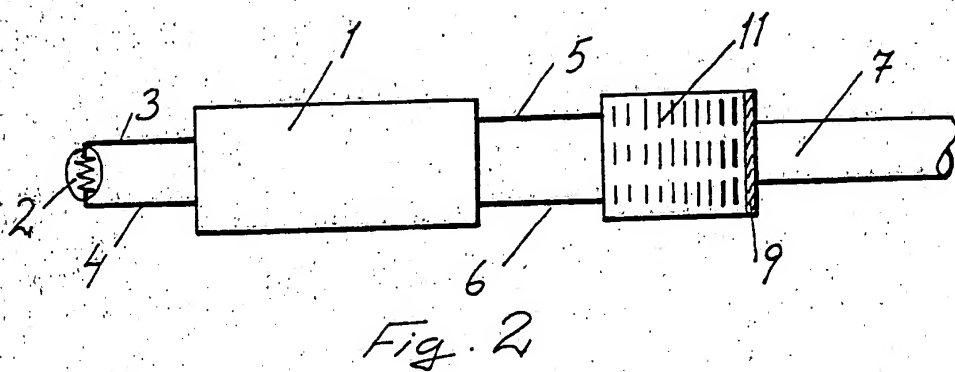
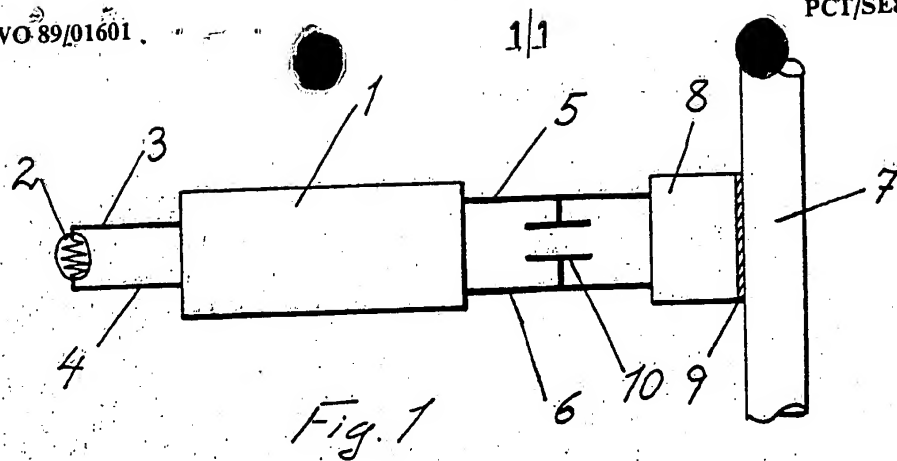
3. The disturbance-protected igniter as claimed in Claim 2, characterized in that said transducer consists of a piezoelectric transducer (8).

4. The disturbance-protected igniter as claimed in Claim 2, characterized in that said transducer consists of an electrolyte (11) which, in the solid state, emits no battery current, but which is melted upon detonation and then emits sufficient current to start the time igniter.

5. The disturbance-protected igniter as claimed in Claim 2, characterized in that said transducer consists of a photocell (12).

6. The disturbance-protected igniter as claimed in Claim 5, characterized in that it displays a connection or passage disposed in the vicinity of the transducer (8, 11, 12), being in the form of a channel or the like for a detonating fuze (7, 7a).

5. 7. The disturbance-protected igniter as claimed in Claim 6, characterized in that the passage or channel for the detonating fuze (7) passes through the igniter such that the detonating fuze may be drawn past the igniter to further igniters.



INTERNATIONAL SEARCH REPORT

International Application No. PCT/SE88/00409

I. CLASSIFICATION F SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC 4		
F 42 C 11/06, C 06 C 5/04		
II. FIELDS SEARCHED		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC 4	C 06 C 5/00, /04; F 42 B 3/10-/18; F 42 C 1/12, 9/00-/16, 11/00, /02, /06, 13/02, 19/06, 19/08, 19/12; F 42 D 1/02 .../...	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
SE, NO, DK, FI: classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
A	DE, A, 1 933 377 (DYNAMIT NOBEL AG) 18 February 1971; See page 3, lines 14-21, figure 1	1-2
A	EP, A1, 0 014 401 (DIEHL GMBH & CO) 20 August 1980; See whole document	1-2
A	NO, B, 137 975 (IMPERIAL CHEMICAL INDUSTRIES LTD) 20 February 1978; See page 3, line 30-page 5, line 19, figure 1	1-3
<p>* Special categories of cited documents: 10</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1988-10-28	1988 -11- 07	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	Bengt Christensson Bengt Christensson	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II. Fields searched (cont).

US C1 102: 25, 27, 28, 75, 82, 210,
275-277

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
☐ No protest accompanied the payment of additional search fees.